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Pubertal Status Predicts Back Pain, Overtiredness, and Dizziness in American and Dutch Adolescents

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KEY WORDS

functional somatic symptoms, pain, pubertal development, gender differences

ABBREVIATIONS

FSS—functional somatic symptoms

TRAILS—Tracking Adolescents' Individual Lives Survey

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WHAT'S KNOWN ON THIS SUBJECT: Functional somatic symptoms, such as overtiredness and pain, are more common in girls than in boys, and this difference tends to increase during adolescence. Whether this increase in gender difference can be explained by pubertal development is unclear.



WHAT THIS STUDY ADDS: Two large cohort studies in the Netherlands and the United States revealed no significant gender differences in the association between pubertal development and functional somatic symptoms. Pubertal stage at baseline positively predicted back pain, overtiredness, and dizziness at follow-up.

abstract



OBJECTIVE: Functional somatic symptoms, symptoms for which no organic pathologic basis can be found, are more prevalent in girls than in boys, and this difference tends to increase during adolescence. This might be explained, at least in part, by pubertal development. We hypothesized that pubertal maturation predicts the development of most functional somatic symptoms and that this especially is true for girls.

METHOD: We used 2 longitudinal population-based studies to examine our hypotheses: the Longitudinal Study of Pain in Adolescents in Seattle ($n = 1996$ [49.7% girls]) and the Dutch Tracking Adolescents' Individual Lives Survey ($n = 2230$ [51.0% girls]). Two assessment waves of each study were used. American adolescents were younger than Dutch adolescents at the first (11.6 vs 13.6) and second (14.5 vs 16.2) assessment waves, but they were in about the same pubertal development stage. Functional somatic symptoms were measured by pain questions, the Symptom Checklist-90, and the Youth Self-report. The Pubertal Development Scale was used to assess pubertal development on a continuous scale in both cohorts.

RESULTS: Ordinal logistic regression analyses revealed that American and Dutch adolescents at a later pubertal status at baseline were more likely (odds ratios ranged from 1.24 to 1.61) to report back pain, overtiredness, and dizziness but not stomach pain and headache 2 to 3 years later. Although these relationships were not equally strong for boys and girls, no significant gender differences were found.

CONCLUSIONS: Pubertal status predicted the frequency of some, but not all, functional somatic symptoms at follow-up. *Pediatrics* 2011;128: 553–559

Functional somatic symptoms (FSS), symptoms for which no organic pathologic basis can be found, are common in adolescents worldwide.^{1,2} These symptoms can have a significant impact on adolescents' lives, by causing school-related problems, problems with peers, and problems in the family.³ In general, girls experience more FSS than boys, and this difference increases during adolescence.⁴ It is unknown which factors are responsible for this increase in gender difference. One possibility is that pubertal development plays a role. Cross-sectional studies suggest that the association between pubertal development and FSS is different in boys and girls.⁴⁻⁶ However, research in this field is scarce, and findings are sometimes contradictory. Most studies show that musculoskeletal symptoms, headache, dizziness, and fatigue increase during pubertal development in girls.⁴⁻⁶ Findings on the relationship between gastrointestinal symptoms and pubertal development in girls are less consistent because some studies found a negative association, some found a positive association, and some did not find a significant association between the two.⁴⁻⁷ In boys, pubertal development generally is associated with a larger decrease in gastrointestinal symptoms and with a smaller increase in musculoskeletal symptoms, headache, dizziness, and fatigue than in girls, resulting in a lower overall prevalence of FSS in boys than in girls at the completion of pubertal development.⁴⁻⁶

The relationship between specific FSS and pubertal development has, to the best of our knowledge, only been studied longitudinally for headache and stomach pain.^{7,8} As a consequence, it is unknown whether other FSS increase or decrease as adolescents proceed through pubertal development and whether this depends on gender. We

hypothesized that (1) pubertal maturation is a risk factor for development of back pain, headache, dizziness, and overtiredness but not for gastrointestinal symptoms and (2) the relationship between pubertal maturation and specific somatic symptoms is stronger in girls than in boys. To enlarge the robustness of our findings, we studied these hypotheses with longitudinal data from 2 samples, 1 consisting of Dutch and 1 of American adolescents.

METHODS

The Tracking Adolescents' Individual Lives Survey

The Tracking Adolescents' Individual Lives Survey (TRAILS) is a prospective cohort study of Dutch adolescents. The data reported here come from the second and third assessment waves of the TRAILS, which ran from September 2003 to December 2004 and from September 2005 to August 2008, respectively. The questionnaires used in the current study were all filled out by the adolescents at school under the supervision of a TRAILS employee.

TRAILS participants were selected from 5 municipalities in the north of the Netherlands, including both urban and rural areas. All children born between October 1, 1989, and September 30, 1990 (first 2 municipalities), or between October 1, 1990, and September 30, 1991 (last 3 municipalities), were eligible for inclusion, provided that their schools were willing to cooperate and that they were able to participate in the study. More than 90% of the schools, accommodating 3145 children, agreed to participate in the study. A small proportion (6.7%) of these children was excluded because of mental or physical incapability or language problems. Of the remaining 2935 children, 76.0% ($n = 2230$ [50.8% girls]; mean age: 11.1 years; SD: 0.6; range: 10–12) were enrolled in the study. Information about the sample

selection and differences between responders and nonresponders at baseline have been described elsewhere.⁹ A total of 10% of the sample had at least 1 parent born in a non-Western country.

Of 2230 baseline participants, 96.4% ($n = 2149$ [51.0% girls]; mean age: 13.7 years; SD: 0.5; range: 12–15) participated in the first follow-up assessment (T2), which was 2 to 3 years after assessment wave 1 (T1). At the third assessment wave (T3), which was 2 to 3 years after T2, the response was 81.4% ($n = 1816$ [53.3% girls]; mean age: 16.3; SD: 0.7; range: 15–18). Attrition at the second assessment was not associated with psychopathology.¹⁰ Because the instruments used at T2 and T3 were most comparable with the instruments used in Seattle, Washington, data from these waves were used in the current study. The study was approved by the Dutch Central Committee on Research Involving Human Subjects. Parents' and adolescents' written informed consent was obtained.

The Longitudinal Study of Pain in Adolescents in Seattle

The Longitudinal Study of Pain in Adolescents in Seattle is a longitudinal cohort study in American adolescents. Subjects in this cohort study were boys and girls, initially all aged 11 years, who were randomly selected from the enrollees of Group Health, a large nonprofit integrated health care system in Washington state. The study included a baseline interview (which ran from May 2000 to April 2001) and a 3-year follow-up interview (which ran from April 2003 to March 2004), each conducted by telephone. Both interviews were used for the current study. Children not sufficiently proficient in English to understand the interview questions or those whose parents were not sufficiently proficient in Eng-

lish to provide informed consent were considered ineligible.

Of all adolescents invited for this study 49% ($n = 1996$ [49.7% girls]; mean age: 11.6; SD: 0.3; range: 11.0–12.1) participated at baseline. Information about sample selection and differences between responders and nonresponders at baseline can be found elsewhere.⁴ The majority of adolescents (66.5%) described their race as white. At the 3-year telephone follow-up interview 91.0% of the adolescents ($n = 1817$ [49.4% girls]; mean age: 14.5; SD: 0.3) participated again. All procedures were approved by the institutional review boards of Group Health and the University of Washington. Both the parent or legal guardian and the child provided informed consent (adults) or assent (children).

Functional Somatic Symptoms

Both studies assessed back pain, stomach pain, and headache, the most prevalent types of pain in adolescents. The adolescents were asked how often they had experienced these symptoms during the past 3 months. In the Netherlands, adolescents filled out questionnaires with 7 response categories: “not at all,” “less than once a month,” “once a month,” “two to three times a month,” “once a week,” “two to six times a week,” and “almost every day.” In the United States, adolescents could answer the interviewer with 4 response categories: “not at all,” “fewer than half of the days,” “more than half of the days,” and “almost every day.” There were few adolescents who reported having pain almost every day in either the Dutch or American sample. Therefore, in the Dutch sample, this category was combined with the category “Two to six times a week” and in the American sample with “More than half of the days,” resulting in 6 response categories in the Dutch and 3 in the American sample. In the United

States, subjects were explicitly asked to report pains that lasted a whole day or more or pains that they experienced several times in a year and not to report little aches and pains that did not last very long. In the Netherlands, no such restrictions were made.

In the Dutch study, FSS other than pain symptoms were assessed with the Youth Self-report,¹¹ and in the American study, they were assessed during the telephone interview with the Symptom Checklist-90.¹² We used only items of both questionnaires that we considered comparable. These items were overtiredness and dizziness without obvious reason from the Youth Self-report, which could be rated on a 3-point scale (“not at all,” “sometimes/a little bit,” or “often/a lot”), and feeling low in energy or slowed down and faintness or dizziness from the Symptom Checklist, which could be rated on a 5-point scale (“not at all,” “a little bit,” “moderately,” “quite a bit,” or “extremely”). The categories “quite a bit” and “extremely” were combined because few adolescents reported experiencing these symptoms extremely. The time frame of the Youth Self-report was 6 months, whereas that of the Symptom Checklist was 1 month.

Pubertal Development

In both studies, the Pubertal Development Scale, which is known to be a reliable instrument,^{13,14} was used to measure pubertal development. The Pubertal Development Scale assesses development on 5 characteristics for each gender. These characteristics include growth spurt in height, skin changes and body hair for both boys and girls, breast development and menarche in girls, and voice change and facial-hair growth in boys. Subjects were asked to respond on a self-report questionnaire (Dutch) or in a telephone interview (American) to each item on a 4-point ordinal scale

(no development = 1, development barely begun = 2, development definitely underway = 3, and development already completed = 4). The menarche item was scored as 1 if premenarche and 4 if menstrual periods had begun. The mean item score of the 5 items was calculated and used as a continuous measure to increase the power to detect an effect.¹⁵

Statistical Analyses

We performed ordinal logistic regression analyses to test our hypotheses. This analysis method is an extension of binary logistic regression and is appropriate when the outcome variable contains more than 2 ordinal categories. An important assumption to perform these analyses is the proportional odds assumption. Violations of this assumption were tested by performing Brant tests.¹⁶ By performing ordinal logistic regression analyses, we examined whether pubertal status at the baseline of this study (ie, at baseline in the American sample and at T2 in the Dutch sample) predicted a specific FSS at follow-up (ie, at 3-year follow-up in the American sample and at T3, which was 2 to 3 years after T2, in the Dutch sample). The analyses were adjusted for gender because, in general, girls have more FSS^{1,2} and are further along in pubertal development than boys at a given age.¹⁷ We performed all analyses again, adjusting for age, to rule out that age, rather than pubertal status itself, predicted the relationship between pubertal status and FSS. To examine whether pubertal status truly predicted the direction of development of FSS, we performed the same analyses adjusting for the corresponding symptom at the first time point.

To test our second hypothesis that significant gender differences exist, an interaction term of gender and pubertal status at baseline was computed. We

TABLE 1 Descriptive Statistics of the Dutch and American Girls and Boys at Baseline and Follow-up 2 to 3 Years Later

	Americans at Baseline		Dutch at Baseline		Americans at Follow-up		Dutch at Follow-up	
	Valid <i>n</i>	Mean (SD) or %	Valid <i>n</i>	Mean (SD) or %	Valid <i>n</i>	Mean (SD) or %	Valid <i>n</i>	Mean (SD) or %
Girls								
Age, y	992	11.6 (0.3)	1069	13.6 (0.5)	897	14.5 (0.3)	952	16.3 (0.7)
Pubertal status	911	2.3 (0.6); range: 1.0–4.0	1001	2.7 (0.7); range: 1.0–4.0	880	3.5 (0.5); range: 1.6–4.0	866	3.3 (0.4); range: 1.2–4.0
BMI, kg/m ²	904	19.6 (3.9)	1028	19.3 (3.3)	888	22.0 (4.2)	834	21.7 (3.2)
Headache	989	19.2 ^{a,b}	1069	56.7 ^{a,b}	897	21.4 ^{a,b}	871	51.6 ^{a,b}
Stomach pain	991	27.8 ^{a,b}	1068	46.9 ^{a,b}	897	16.7 ^{a,b}	875	35.9 ^{a,b}
Back pain	989	15.0 ^{a,b}	1068	30.5 ^{a,b}	896	25.2 ^{a,b}	874	35.6 ^{a,b}
Dizziness	992	33.3 ^{a,c}	1072	40.9 ^{a,d}	897	33.9 ^{a,c}	880	42.6 ^{a,d}
Overtiredness or lack of energy	991	57.3 ^{a,c}	1070	43.1 ^{a,d}	897	55.5 ^{a,c}	880	54.2 ^{a,d}
Boys								
Age, y	1004	11.6 (0.3)	1018	13.6 (0.5)	920	14.5 (0.3)	867	16.3 (0.7)
Pubertal status	970	1.9 (0.4) range: 1.0–3.6	1006	2.1 (0.6) range: 1.0–4.0	915	2.7 (0.5) range: 1.0–4.0	768	3.0 (0.5) range: 1.0–4.0
BMI, kg/m ²	951	19.9 (4.3)	1000	18.7 (3.1)	914	22.3 (4.5)	759	20.9 (3.4)
Headache	1002	16.7 ^{a,b}	1013	44.5 ^{a,b}	920	13.5 ^{a,b}	769	34.9 ^{a,b}
Stomach pain	1002	22.0 ^{a,b}	1015	37.4 ^{a,b}	920	12.1 ^{a,b}	771	19.9 ^{a,b}
Back pain	998	11.1 ^{a,b}	1015	22.1 ^{a,b}	919	16.9 ^{a,b}	769	27.4 ^{a,b}
Dizziness	1002	32.0 ^{a,c}	1019	24.5 ^{a,d}	919	25.7 ^{a,c}	772	22.0 ^{a,d}
Overtiredness or lack of energy	1002	58.6 ^{a,c}	1016	29.0 ^{a,d}	919	47.6 ^{a,c}	772	29.5 ^{a,d}

^a Percentage of girls and boys who experienced this symptom at least once during the ^bpast 3 months, the ^cpast month, or the ^dpast 6 months.

examined whether this interaction term, adjusted for the main effects of gender and pubertal status at baseline, predicted a specific FSS at follow-up. A result was considered statistically significant when the 95% confidence interval of the odds ratio did not include 1. Stata version 10 (Stata Corp, College Station, TX) was used to perform all analyses.

RESULTS

Descriptive Statistics

The Dutch boys and girls were older than the Americans, but the samples were fairly comparable with regard to mean pubertal development score (Table 1). Adolescents from both co-

horts were, on average, already in a mid-pubertal development stage at baseline. That American adolescents start their pubertal development earlier than European adolescents is in line with previous research.^{18,19} Furthermore, American adolescents had slightly higher BMI scores than Dutch adolescents, in keeping with known national differences.^{19,20} Dutch adolescents reported having experienced pain more often than American adolescents.

Pubertal Status as a Predictor of FSS at Follow-up

As is shown in Table 2, the higher the pubertal status of adolescents at baseline, the more likely they were to re-

port back pain, overtiredness, and dizziness but not stomach pain and headache at follow-up 2 to 3 years later. After adjusting for age, results were essentially the same. When we adjusted for the corresponding baseline FSS, results pointed in the same direction and remained statistically significant except for the relationship between pubertal development and dizziness in Dutch adolescents. The Brant test did not indicate that the proportional odds assumption was violated for any of the analyses ($P > .05$).

Gender Differences

Results of the analyses of the relationships between pubertal status at base-

TABLE 2 Longitudinal Relationship Between Pubertal Development at Baseline and FSS at Follow-up 2 to 3 Years Later Analyzed With Ordinal Logistic Regression Analyses

	Headache at Follow-up	Stomach Pain at Follow-up	Back Pain at Follow-up	Overtiredness or Lack of Energy at Follow-up	Dizziness at Follow-up
American adolescents, pubertal status at baseline	1.18 (0.94–1.48) ^a	1.26 (0.98–1.62) ^a	1.61 (1.30–1.99) ^{a,c}	1.33 (1.12–1.58) ^{a,c}	1.35 (1.11–1.64) ^{a,c}
	1.11 (0.87–1.41) ^b	1.25 (0.97–1.61) ^b	1.52 (1.22–1.89) ^{b,c}	1.25 (1.05–1.49) ^{b,c}	1.26 (1.03–1.53) ^{b,c}
Dutch adolescents, pubertal status at baseline	1.07 (0.93–1.25) ^a	0.88 (0.75–1.04) ^a	1.34 (1.13–1.57) ^{a,c}	1.30 (1.11–1.51) ^{a,c}	1.24 (1.05–1.46) ^{a,c}
	1.07 (0.92–1.25) ^b	0.91 (0.76–1.08) ^b	1.24 (1.04–1.46) ^{b,c}	1.26 (1.08–1.48) ^{b,c}	1.16 (0.98–1.37) ^b

Data are odds ratio (95% confidence interval).

^a Adjusted for gender.

^b Adjusted for gender and the corresponding baseline FSS.

^c Significant effect.

line and specific FSS at follow-up stratified by gender pointed mostly in the same direction for each gender (Table 3). Although relationships generally were in the same direction for boys and girls, the results were not always equally strong for each gender and sometimes failed to reach significance in boys (Table 3). The interaction effects, however, indicated that these gender differences were not statistically significant (all P values > 0.18) (Table 3).

Growth Spurt and Back Pain

Because pubertal status at baseline was only significantly related to back pain and not to headache and stomach pain, we wondered whether this association could be explained by a growth spurt. We therefore examined whether growth spurt (ie, the specific item from the Pubertal Development Scale) at baseline predicted back pain at follow-up. Growth spurt at baseline was not a significant predictor of back pain at follow-up in the American sample (odds ratio: 1.04 [95% confidence interval: 0.89–1.21]) or in the Dutch sample (odds ratio: 1.13 [95% confidence interval: 0.98–1.31]).

DISCUSSION

This study indicates that Dutch and American adolescents who are in a later pubertal stage at baseline report more back pain, overtiredness, and dizziness but not more stomach pain or headache 2 to 3 years later. We did

not find any significant gender difference in the longitudinal relationship between pubertal development and FSS.

A strength of our research is that we used 2 large population-based studies, 1 of American and 1 of Dutch adolescents. This enhances the generalizability of our findings because most of the findings were comparable in both studies despite racial and age differences. Furthermore, the use of 2 samples enhanced the robustness of our findings because different instruments (eg, different questionnaires with different response categories) were used in the 2 studies. Despite these methodological differences, results were fairly similar in both samples. Another advantage is that we had longitudinal data available, which allowed us to examine whether pubertal status, rather than age, was predictive of FSS at follow-up.

We have to acknowledge 2 limitations to our study. First, adolescents already were, on average, in a mid-pubertal development stage at the beginning of our studies. Therefore, we might have missed some effects of early pubertal development. Another possible shortcoming is that we are not sure if the FSS measured were a result of conventional medical conditions. In the Youth Self-report, it was stated that the symptoms had to occur without obvious cause, but in the other questionnaires used to assess FSS, no such re-

strictions were made. However, medical conditions are seldom found in adolescents with common somatic complaints.^{21,22} Moreover, findings in the 2 cohorts were largely comparable, and the prevalence of symptoms attributed to medical conditions is likely to be different in the 2 cohorts because the Dutch adolescents were asked only to report symptoms without obvious cause. Therefore, medical conditions are not likely to have substantially influenced the associations between pubertal status and FSS.

Some differences between the samples have to be noted. Dutch adolescents reported having experienced pain much more often than American adolescents. This difference most likely can be explained by the restrictions made in the American questionnaire not to report minor pains and only to report pains that lasted for 1 day or longer. Furthermore, in Seattle the data were collected by interviews, whereas the Dutch adolescents reported their symptoms on a questionnaire, which in general results in higher rates of symptom report. In addition to mean pain frequency, the response rates, response categories, the duration of the recall period of overtiredness and dizziness, follow-up time intervals, and ethnicity differed between the samples. Despite all these methodological differences, results were essentially the same in each sam-

TABLE 3 Longitudinal Relationship Between Pubertal Development at Baseline and FSS at Follow-up 2 to 3 Years Later, Stratified According to Gender

	Headache at Follow-up	Stomach Pain at Follow-up	Back Pain at Follow-up	Overtiredness or Lack of Energy at Follow-up	Dizziness at Follow-up
American girls, pubertal status at baseline	1.24 (0.94–1.61)	1.27 (0.94–1.72)	1.50 (1.16–1.93) ^b	1.44 (1.16–1.78) ^b	1.29 (1.02–1.63) ^b
American boys, pubertal status at baseline	1.02 (0.66–1.59)	1.23 (0.78–1.93)	1.90 (1.28–2.82) ^b	1.15 (0.86–1.53)	1.47 (1.05–2.06) ^b
P value of the interaction effect ^a	.61	.90	.34	.19	.55
Dutch girls, pubertal status at baseline	1.14 (0.95–1.37)	0.91 (0.74–1.10)	1.31 (1.07–1.61) ^b	1.29 (1.07–1.55) ^b	1.30 (1.06–1.58) ^b
Dutch boys, pubertal status at baseline	0.96 (0.75–1.23)	0.83 (0.61–1.13)	1.37 (1.05–1.79) ^b	1.31 (1.00–1.70) ^b	1.11 (0.83–1.49)
P value of the interaction effect ^a	.25	.85	.69	.99	.39

Data are odds ratio (95% confidence interval).

^a P value of the interaction effect of gender.

^b Significant effect.

ple, which suggests that our findings are quite robust.

The longitudinal relationships we found between pubertal status and FSS are largely comparable with the cross-sectional associations in our previous studies.^{4,5} In contrast to the Dutch baseline study⁵ and a previous longitudinal study by Stanford et al,⁷ the current study did not find that adolescents in a lower pubertal stage report more stomach pain. Both previous studies indicated that lagging behind one's peers in pubertal development is associated with reporting stomach pain. Because most adolescents in the current study already were in a mid-pubertal development stage, the effect of lagging behind one's peers might have been missed. The largest difference with the American cross-sectional study⁴ is that the current study did not reveal a longitudinal positive association between pubertal status and headache in girls. An explanation might be the lack of older adolescents in the current study compared with the cross-sectional study. It might take some time before having reached a mature pubertal status influences the frequency of headache in girls. This might also explain why no cross-sectional association was found between pubertal status and headache in girls in the Dutch baseline study, when participants were, on average, even younger than in the American sample. The explanation also is in line with a previous study by Kröner-Herwig et al,⁸ who found that reaching menarche 2 or more years ago was predictive of headache, whereas having reached menarche only 1 year ago was not associated with headache. Al-

though intuitively plausible, growth spurt did not explain why we found a longitudinal association between pubertal development and back pain but not the other pain symptoms. This is in keeping with previous studies that found that mechanical factors, like carrying backpacks and physical activity, did not predict back pain at follow-up.^{23,24}

Although observed associations between pubertal development and FSS were not always equally strong for boys and girls, we found no statistically significant gender differences in the longitudinal relationship between pubertal status and specific FSS. Therefore, we did not find evidence to support the hypothesis that pubertal development causes girls to experience FSS more frequently than boys during early and mid-adolescence.^{25,26} Gender differences attributed to pubertal development may become apparent during late adolescence, possibly because the sensitizing effects of the sometimes painful physiologic signals associated with menstruation take some time to develop.²⁷ Psychological factors also likely contribute to the increasing difference in the amount of FSS reported by boys and girls during adolescence: growing into adulthood may increase the expectation for boys not to report and thereby decrease the willingness for boys to report FSS.²⁸

CONCLUSIONS

Pubertal status was associated with some, but not all, FSS, suggesting that biological factors are differentially involved in the etiology of various FSS. It is tempting to speculate that back

pain, dizziness, and overtiredness predominantly result from a different biological pathway than stomach pain and headache, but this needs to be explored further.

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